Los Angeles County Draft Municipal Greenhouse Gas Inventory

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Prepared for:
Los Angeles County

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Acronyms and Abbreviations

AB 32	California Assembly Bill 32 (the Global Warming Solutions Act of 2006)
ARB	California Air Resources Board
BAU	business-as-usual
BTU	British Thermal Unit
Cal EPA	California Environmental Protection Agency
CCAR	California Climate Action Registry
CEC	California Energy Commission
CH_4	methane
CIWMB	California Integrated Waste Management Board
CNG	compressed natural gas
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
County	Los Angeles County
EIA	Energy Information Administration
Ft^3	cubic foot

FY	fiscal year
GHG	greenhouse gases
GJ	gigajoule
GWh	gigawatt hour
GWP	global warming potential
HCFCs	halogenated chlorinated fluorocarbons
HFCs	hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
kWh	kilowatt hour
kg	kilogram
km	kilometer
LA	Los Angeles
LGOP	Local Government Operations Protocol
M^3	cubic meters
MG	million gallons
Mcf	thousand cubic feet
MMBTU	million BTU
MT	metric ton
$MTCO_2em$	etric tons of carbon dioxide equivalent
MWD	Metropolitan Water District
MWh	megawatt hour
N_2O	nitrous oxide
NAFA	National Association of Fleet Administrators
ODS	ozone depleting substances
PFCs	perfluorinated carbons
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SF_6	sulfur hexafluoride
SWP	State Water Project
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VMT	vehicle miles travelled
WBCSD	World Business Council for Sustainable Development
WRIWorld	Resources Institute

1. Executive Summary

Los Angeles County (County) has committed to undertake the following measures that will reduce greenhouse gas (GHG) emissions associated with its internal (also referred to as municipal) operations as a whole:

- Prepare a current year (2009) GHG emissions inventory for County municipal operations;
- Prepare a future year (2020) GHG emissions estimate for County municipal operations;
- Develop a GHG emissions tracking tool to support implementation of GHG reduction measures for County municipal operations; and
- Adopt a GHG Emissions Reduction Plan to comply with the recommendations for local government municipal emissions outlined in Assembly Bill (AB) 32[1].

This document summarizes the 2009 GHG emissions inventory for County municipal operations, including: building energy use, co-generation facilities, vehicle fleet, streetlights and traffic signals, refrigerant usage, landfills, wastewater treatment, water pumps, miscellaneous sources (ammunition, ethylene oxide, CO_2, and acetylene), waste generation, water consumption, and employee commute. In this document, the terms "municipal" and "government" are used interchangeably to define the scope of the inventory. The results of this inventory will form a baseline from which the County can forecast future year (2020) emissions and establish GHG reduction targets. The 2020 emissions inventory and GHG reduction targets will be summarized in subsequent documents, from which the County will develop GHG reduction goals and create of a policy framework to support control and ultimate reduction of GHG emissions from government operations.

This report provides background and introductory information, methodology used to prepare the inventory, and inventory results for each sector included in the analysis.

1.1 Inventory Results

Figures 1, 2 and 3 and Table 1 present a summary of the 2009 GHG emissions inventory for Los Angeles County municipal operations. Figure 1 presents all GHG emissions for the County. Figure 2 presents major sources of GHG

[1] In 2006, California passed Assembly Bill (AB) 32, the Global Warming Solutions Act of 2006. This law established a state goal of reducing GHG emissions statewide to 1990 levels by 2020. This effort is roughly equivalent to the reduction in emissions to a level 15 percent below current levels.

emissions, and Figure 3 presents minor sources. Table 1 shows emissions for each sector its percent contribution to the total inventory.

The largest source of emissions from County operations is landfill waste, which represents 46% of total County emissions for 2009. The County owns a number of large landfills that accept waste from many cities within Los Angeles County, and these emissions represent methane from the decomposition of all waste deposited in these landfills since they were opened. Because landfills represent such a large portion of the County's inventory, significant GHG reduction actions could be identified in this sector, including diversion programs and increased methane capture. The second largest source of emissions is building energy, which is often the largest source of GHG emissions in municipal inventories. Energy efficiency measures could therefore reduce significant amounts of the County's GHG emissions. The third and fourth largest sources are employee commute and vehicle fleet, which indicates that mobile-source fossil fuel combustion contributes significantly to the County's GHG footprint. This also indicates that vehicle fleet reduction measures, such as replacing older vehicles with newer, more efficient vehicles, and employee commute measures, such as rideshare programs and transit subsidies, could also have a significant impact on reducing the County's overall GHG emissions. The fifth largest source is co-generation facilities, which consume natural gas. More efficient boilers and combustion processes have the potential to greatly reduce the Count's emissions in this sector.

Emissions from individual sectors are discussed in greater detail below.

Figure 1. Los Angeles County 2009 Municipal GHG Inventory

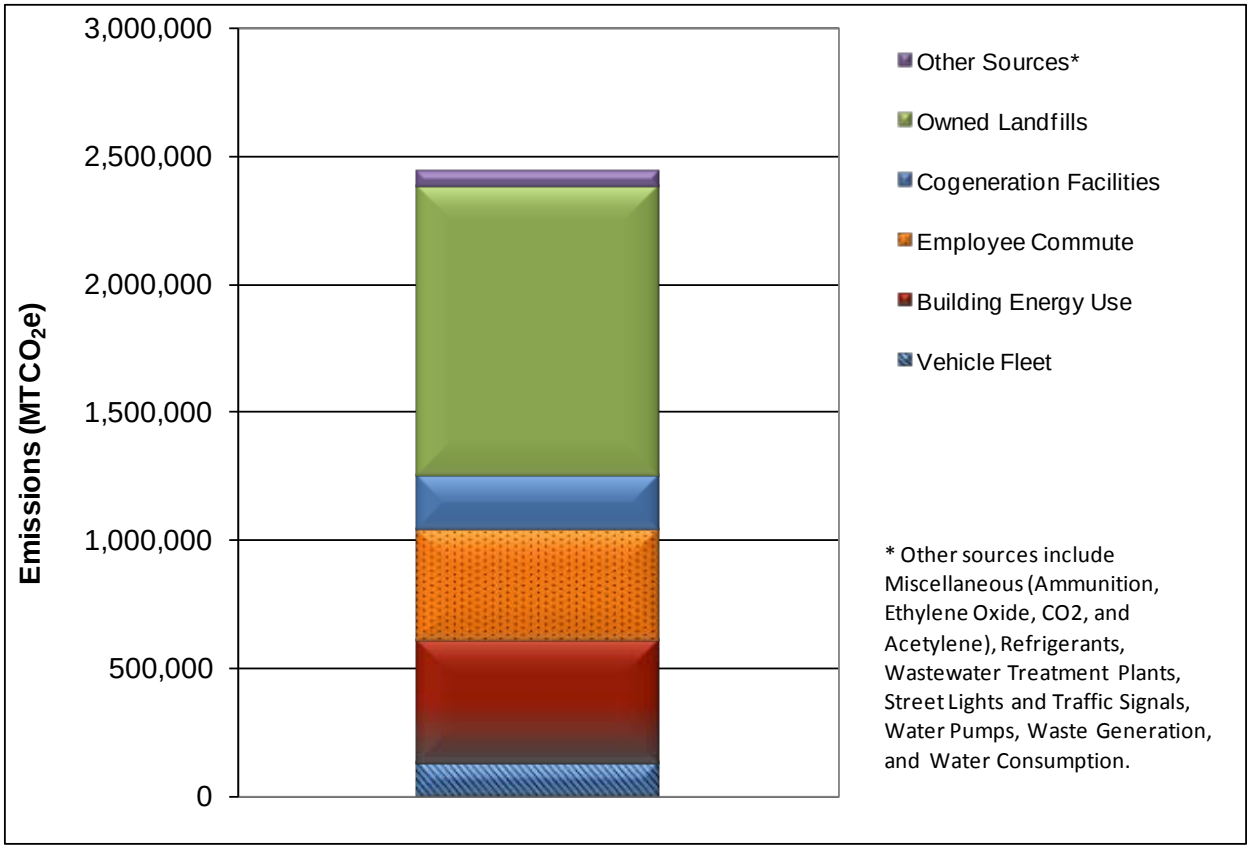
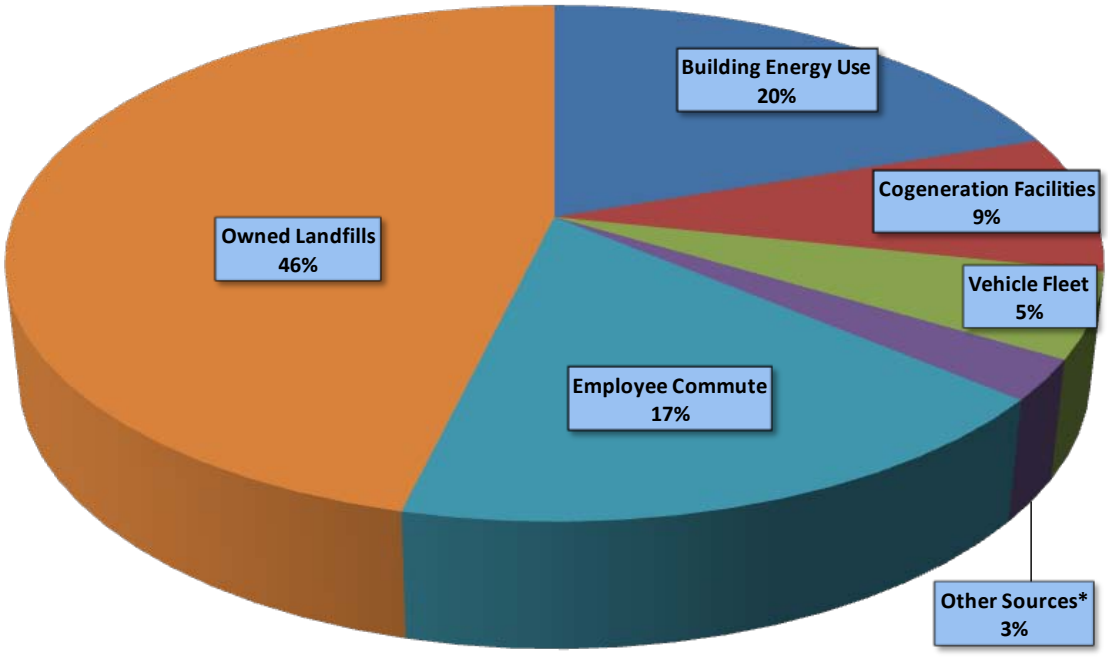


Figure 2. Los Angeles County 2009 Municipal GHG Inventory



* Other sources include Miscellaneous (Ammunition, Ethylene Oxide, CO2, and Acetylene), Refrigerants, Wastewater Treatment Plants, Street Lights and Traffic Signals, Water Pumps, Waste Generation, and Water Consumption

Figure 3. Los Angeles County 2009 Municipal GHG Inventory – *Other Sources*

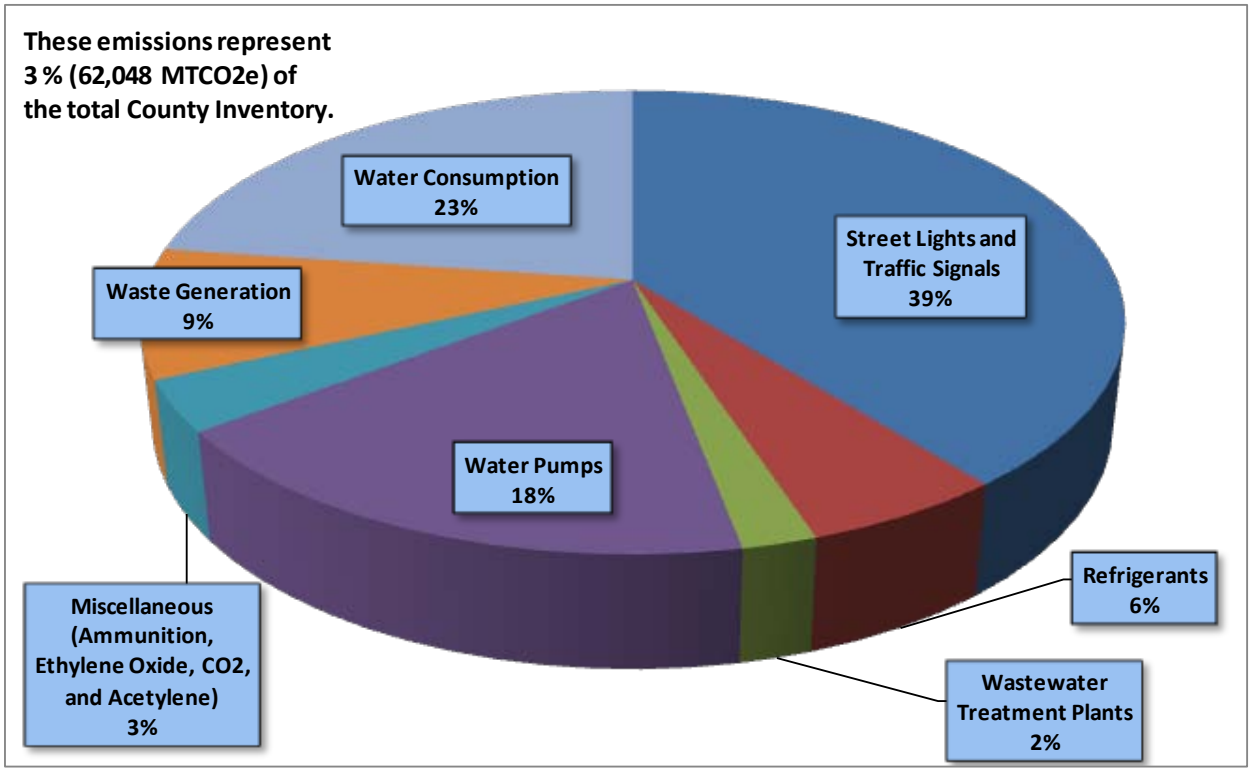


Table 1. Los Angeles County 2009 Municipal GHG Inventory ($MTCO_2e$)

Sector	Emissions	Percent of Scope 1, 2, and 3
Scope 1 and 2 Emissions		
Building Energy Use	482,206	19.8
Cogeneration Facilities	210,423	8.6
Vehicle Fleet	129,512	5.3
Owned Landfills	1,129,157	46.2
Refrigerants	3,507	0.1
Miscellaneous (Ammunition, Ethylene Oxide, CO_2, and Acetylene)	2,201	0.1
Wastewater Treatment Plants	1,295	0.1
Street Lights and Traffic Signals	24,370	1.0
Water Pumps	10,955	0.4
Water Consumption	14,119	0.6
Subtotal (Scope 1 and 2)	2,007,746	
Scope 3 Emissions		
Waste Generation	5,600	0.2
Employee Commute	428,200	17.5
Subtotal(Scope 3)	433,800	17.8
Total (Scope 1, 2, and 3)	2,441,546	100.0

1.2 Inventory Limitations and Recommendations

This inventory identifies significant GHG emissions from County municipal operations and serves as a baseline for emission reduction measures and as a starting point for future GHG emissions inventories. Future updates to the GHG emissions inventory presented in this report should be conducted on an annual basis to ensure that the inventory remains accurate and that data gaps are resolved in a timely manner. This would also enable efficient tracking of the effectiveness of any GHG reduction measures put in place to address these emission sources.

Although considerable efforts were made to obtain activity data from 2009, in some cases this data was unavailable and data from another year was substituted (i.e. fuel consumption for transit vehicles operated by the department of Public Works). In addition, data obtained for certain sectors was provided in an aggregated format. For example, building energy use data provided by the County was aggregated by Utility instead of facility or department. A greater level of detail and disaggregation would strengthen this inventory and greatly increase the potential for the County to identify, quantify, and monitor effective emission reduction actions. Specific data gaps and limitations are identified and discussed on a sector-by-sector basis below.

2. Introduction

The temperature on Earth is regulated by a system commonly known as the "greenhouse effect." GHGs absorb heat radiated from the Earth's surface. As the atmosphere warms, it in turn radiates heat back to the surface to create the greenhouse effect. According to the United States Environmental Protection Agency (USEPA), a GHG is any gas that absorbs infrared radiation in the atmosphere. AB 32 and the CEQA guideline amendments define the following six (6) GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), sulfur hexaflouride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

GHGs are both naturally occurring and anthropogenic (e.g. man-made). Once emitted, GHGs remain in the atmosphere for decades or centuries and can therefore mix globally. Innumerable direct and indirect sources, both natural and anthropogenic, cause increased atmospheric concentrations of GHGs. Natural sources of GHGs include decomposition of organic matter and wildfires. Many human activities add to the levels of naturally occurring gases. Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. Carbon dioxide and nitrous oxide are the two GHGs released in the greatest quantities from mobile sources burning gasoline and diesel fuel. Methane, a highly potent GHG, results from off-gassing associated with agricultural practices and landfills, among other sources. Hydrofluorocarbons and perfluorocarbons are families of synthetic chemicals that are used as substitutes to ozone depleting substances (ODS) being phased out under the Montreal Protocol. Sulfur hexafluoride is used in the electric transmission and distribution systems, as well as various industrial manufacturing processes.

As the global, national, and statewide population and economy continue to grow, anthropogenic emissions of GHGs continue to increase due largely to the burning of fossil fuels. The associated increase in atmospheric concentrations of GHGs will cause a variety of adverse environmental impacts related to large scale changes in the climate system. Climate change impacts of greatest concern for the state of California include: sea-level rise, increased frequency and intensity of wildfire, decreased Sierra snowpack and associated consequences to state water supply, changes in winter precipitation patterns and associated consequences to state water supply, increased frequency and intensity of extreme heat events, and degradation in regional air quality due to warmer temperatures (California Energy Commission 2009; California Natural Resources Agency 2009).

2.1 Inventory Background

Los Angeles County, with the assistance of ICF International (ICF), developed a 2009 GHG inventory for internal operations. The results of the inventory define a baseline emissions level from which future emissions under business-as-usual (BAU) conditions can be projected. The inventory is based on actual 2009 activity data and emission factors and includes all significant contributing sectors to GHG emissions, according to the guidelines of the

California Air Resources Board Local Governments Operations Protocol (2010), as stated below in Section 3.2. This inventory was developed with sufficient detail so as to support identification of GHG reduction measures specific to the County's municipal operations.

The County has submitted GHG emissions reports to the California Climate Action Registry Reporting Online Tool (CARROT) for 2006, 2007, and 2008. The emissions totals reported are 592,362; 634,170; and 634,360 $MTCO_2e$, respectively. These emissions totals include direct emissions from stationary and mobile combustion and process emissions; indirect emissions from purchased electricity; and de minimis emissions (ammunition and ethylene oxide). For the 2009 inventory, ICF has expanded the inventory to include all GHGs identified in the Kyoto Protocol, additional sources recommended by the LGOP, and emissions associated with employee commutes (Scope 3). The emissions total for the 2009 inventory is 2,007,746 $MTCO_2e$ (or 2,441,546 $MTCO_2e$ with Scope 3 emissions included), considerably higher than the previously-reported CCAR inventories. The most significant difference between the California Climate Action Registry (CCAR) inventories and the 2009 inventory is due to the inclusion of County-owned landfills in the 2009 inventory. The landfills account for 1,129,157 $MTCO_2e$ (or 46.2% of the total emissions) of the 2009 emissions inventory. The 2009 inventory also includes emissions from street lights and traffic signals, refrigerant use, and Scope 3 sources (employee commute and waste generation), and fugitive emissions from wastewater treatment.

Los Angeles County covers 4,061 square miles and borders 70 miles of coast on the Pacific Ocean. Numerous natural landscapes, including mountain ranges, valleys, forests, and waterways are found through the County. The County is home to 88 incorporated cities and is the most populous county in the United States. As of January 1, 2009, the California Department of finance listed an estimated population for Los Angeles County of 10,393,195 (California Department of Finance 2009). Municipal operations are managed by the Chief Executive Officer, who oversees approximately 101,701 employees. These employees are organized into 41 departments, each of which is large in comparison to equivalent county-level departments elsewhere in the United States (average employment of 2,481).

This report describes the data sources and methodology used to calculate GHG emissions for County municipal operations, as well as the actual emissions inventory. The boundaries of the inventory are defined as areas of the government's operational control. Emissions for a particular source were included in this inventory if the government entity either wholly owns an operation, facility or source, or has full authority to introduce and implement operating policies at the operation. This includes: government-owned facilities, streetlights/traffic signals, vehicles, buildings (including energy and water usage), and waste and sewage disposal.

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3. Methodology

This section presents the overall methodology used to prepare the municipal GHG emissions inventory for the year 2009. This section discusses the inventory definitions, inventory protocols used, emission factors, and analysis methods.

3.1 Inventory Definitions

Municipal Inventory: The municipal inventory includes GHG emissions associated with the County's services and municipal operations. The County's current municipal inventory is for the year 2009, which represents the most recent year with the necessary data to perform a comprehensive inventory.

Unit of Measure: The unit of measure used throughout this GHG inventory is the metric ton of carbon dioxide (CO_2) equivalent ($MTCO_2e$). This is the international unit that combines the differing impacts of all greenhouse gases into a single unit, by multiplying each emitted gas by its global warming potential (GWP). GWP is the measure of how much a given mass of greenhouse gas contributes to global warming. GWP compares the relative warming effect of the GHG in question to carbon dioxide.[2]

Emissions Type: GHG emissions can be defined as either *direct* (emissions that occur at the end use location such as natural gas combustion for building heating) or *indirect* (emissions that result from consumption at the end use location but occur at another location such as emissions from electricity). This report addresses both types of emissions. In addition, all references to *emissions* are equivalent to *GHG emissions.*

3.2 Inventory Protocols

A number of widely accepted protocols for estimating GHG emissions were used to prepare the community and municipal inventory. The protocols used in the development of this inventory include the following:

[2] The GWP of CO_2 is, by definition, one (1). The GWP values used in this report are based on the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) and United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines and are as follows: CO_2 = 1, Methane (CH_4) = 21, Nitrous Oxide (N_2O) = 310, Sulfur Hexaflouride (SF_6) = 23,600 (IPCC 1996; UNFCCC 2006). Although the IPCC Fourth Assessment Report (AR4) presents different GWP estimates, the current inventory standard relies on SAR GWPs to comply with reporting standards and consistency with regional and national inventories (USEPA 2009a).

- California Air Resources Board Local Governments Operations Protocol (2010). This protocol is the standard for estimating emissions resulting from government buildings and facilities, government fleet vehicles, wastewater treatment and potable water treatment facilities, landfill and composting facilities, and other operations.
- California Climate Action Registry and General Reporting Protocol (2009a). This protocol provides guidance for preparing GHG inventories in California.

The LGOP employs the convention of categorizing local government emission sources as Scope 1 (direct), Scope 2 (indirect), and Scope 3 (other indirect). The LGOP defines these emissions as follows (ARB 2008):

- Scope 1: All direct GHG emissions (with the exception of direct CO_2 emissions from biogenic sources).
- Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.
- Scope 3: All other indirect emissions not covered in Scope 2 that are not under the control or influence of the local government, such as the emissions resulting from the extraction and production of purchased materials and fuels, and transport-related activities in vehicles not owned or controlled by the reporting entity.

Scope 1, 2, and 3 emissions were quantified and included in the municipal inventory. For example, direct emissions associated with on-site natural gas use are included in Scope 1 because these emissions are subject to the County's influence or control. Indirect GHG emissions associated with electricity use are included in Scope 2, since these emissions can occur outside of the County, but are subject to the County's influence or control.

3.3 Emission Factors

Emission factors and references are summarized in Table 2. These emission factors were used to calculate GHG emissions from activity data, such as kilowatt-hour (kWh) of electricity consumed for lighting or gallons of gasoline fuel combusted for on-road transportation.

Table 2. GHG Emission Factors

Source	Emission Factor	Reference
Energy and Stationary Fuels		
Electricity	0.28617 kg CO_2/kWh[1]	CCAR 2010a (2007 data)
	0.49719 kg CO_2/kWh[2]	CCAR 2010b (2007 data)
	0.55696 kg CO_2/kWh[3]	CCAR 2010c (2007 data)
	0.48308 kg CO_2/kWh[4]	CCAR 2010d (2005 data)
	0.75484 kg CO_2/kWh[5]	CCAR 2010e (2006 data)
	0.328 kg CO_2/kWh[6]	EPA 2010a (2007 data)
	0.000014 kg CH_4/kWh	EPA 2010a (2007 data)
	0.000004 kg N2O/kWh	EPA 2010a (2007 data)
Natural Gas	53.3 kg CO_2/GJ	IPCC 2006
	0.005 kg CH_4/GJ	IPCC 2006
	0.0001 kg N_2O/GJ	IPCC 2006
Vehicle Fuels		
Diesel	10.15 kg CO_2/US Gallon	CCAR 2009
	0.00015 kg CH_4/US Gallon	IPCC 2006
	0.00015 kg N_2O/US Gallon	IPCC 2006
Gasoline	8.78 kg CO_2/US Gallon	CCAR 2009
	0.00013 kg CH_4/US Gallon	IPCC 2006
	0.0002 kg N_2O/US Gallon	IPCC 2006
Propane	5.79 kg CO_2/US Gallon	CCAR 2009
	0.000992 kg CH_4/US Gallon	CCAR 2009 and NAFA 2010
	0.002631 kg N_2O/US Gallon	CCAR 2009 and NAFA 2010
CNG	1.906992 kg CO_2/m3	IPCC 2006
	0.011127 kg CH_4/m3	IPCC 2006
	0.00099kg N_2O/m3	IPCC 2006
Ethanol	1.329026 kg CO_2/US Gallon	EIA 2010
	0.000782 kg CH_4/US Gallon	EPA 2010b and Cal EPA 2009
	0.000952 kg N_2O/US Gallon	EPA 2010b and Cal EPA 2009
Other Transportation Fuels		
Aircraft Gasoline	8.31 kg CO_2/US Gallon	CCAR 2009
	0.00704 kg CH_4/US Gallon	CCAR 2009
	0.00027 kg N_2O/US Gallon	CCAR 2009
Jet Fuel	9.57 kg CO_2/US Gallon	CCAR 2009
	0.00011 kg CH_4/US Gallon	CCAR 2009

Source	Emission Factor	Reference
	0.00031 kg N_2O/US Gallon	CCAR 2009
Marine Diesel	74.1 kg CO_2/US Gallon	IPCC 2006
	0.007 kg CH_4/US Gallon	IPCC 2006
	0.002 kg N_2O/US Gallon	IPCC 2006
Rail Transportation	0.172277 kg CO_2/km	LA Metro 2010 and 2009
Ammunition		
9MM	0.0907 g CO_2/Round	EPA 2008
	0.0006 g CH_4/Round	EPA 2008
38 Special	0.0953 g CO_2/Round	EPA 2008
	0.0003 g CH_4/Round	EPA 2008
45 Pistol	0.0998 g CO_2/Round	EPA 2008
	0.0004 g CH_4/Round	EPA 2008
223 Rumination Rifle/ 308 Winchester Rifle	0.0340 g CO_2/Round	EPA 2008
	0.0002 g CH_4/Round	EPA 2008
12 Gauge Shotgun	0.5897 g CO_2/Round	EPA 2008
	0.0059 g CH_4/Round	EPA 2008
Other Gases		
Acetylene Ethylene Oxide	3.68 kg CO_2/m^3 2kg CO_2/kg C_2H_4O	CCAR 2009
Water-Related Electricity Intensities for Southern California		
Water supply and conveyance	9,727 kWh/MG	CEC 2006b
Water Treatment	111 kWh/MG	CEC 2006b
Water Distribution	1,272 kWh/MG	CEC 2006b
Wastewater Treatment	1,911 kWh/MG	CEC 2006b

[1] Emission factor applies to electricity delivered to Southern California Edison customers.

[2] Emission factor applies to electricity delivered to City of Burbank customers.

[3] Emission factor applies to electricity delivered to Los Angeles Department of Water and Power customers.

[4] Emission factor applies to electricity delivered to City of Glendale customers.

[5] Emission factor applies to electricity delivered to City of Pasadena customers.

[6] Emission factor applies to electricity delivered to City of Azusa customers.

3.4 Analysis Methods

As defined above, the municipal inventory includes GHG emissions associated with the County's services and municipal operations. The guidelines of the LGOP (ARB et al. 2008) were followed in developing this inventory, except where noted. This inventory utilizes an "operational control approach," as defined in the LGOP, to set the inventory's organizational boundaries (ARB et al. 2010):

> *Operational Control Approach: A local government has operational control over an operation if the local government has the full authority to introduce and implement its operating policies at the operation. One or more of the following conditions establishes operational control:*
>
> - *Wholly owning an operation, facility, or source*
> - *Having the full authority to introduce and implement operational and health, safety and environmental policies*

This approach is corroborated by the "operational control approach," as defined in the World Resources Institute and World Business Council for Sustainable Development (WRI/WBCSD) GHG Protocol (WRI/WBCSD 2004). In this context, the municipal inventory will include 100 percent of the GHG emissions from City activities over which it has operational control. This approach was selected because it most accurately accounts for GHG emissions from the County's operations. The following emissions sectors are included in the municipal inventory. The data source for each emission sector is also listed.

- *Building Energy Use – Scope 1 and 2:* natural gas and electricity consumption for County owned and operated facilities. Data provided by the County.
- *Cogeneration Facilities – Scope 1:* natural gas and electricity consumption for County owned and operated cogeneration facilities. Data provided by the County.
- *Vehicle Fleet – Scope 1:* fuel *consumption* for County fleet vehicles. Data provided by the County.
- *Owned Landfills – Scope 1:* Methane emissions from landfills owned and operated by the County. Data provided by the County.
- *Refrigerants – Scope 1*: High-GWP gases from County own refrigeration and air conditioning systems in buildings and vehicles. Data provided by *the* County.
- *Miscellaneous (Ammunition, Ethylene Oxide, CO_2, and Acetylene) – Scope 1:* Emissions associated with gun powder, ethylene oxide, and welding gas. Data provided by the County.
- *Wastewater Treatment Plants – Scope 1 and 2*: Electricity consumption and fugitive emissions from wastewater treatment plants owned and operated by the County. Data provided by the County.

- *Streetlights and Traffic Signals – Scope 2:* electricity consumption for County owned and operated streetlights and traffic signals. Data *provided* by the County.
- *Water Pumps – Scope 2*: Electricity *consumption* from water pumps owned and operated by the County. Data provided by the County.
- *Water Consumption – Scope 2*: *Electricity* consumption associated with water supply and conveyance, water treatment, water distribution, and wastewater treatment, Data provided by the County
- *Waste Generation – Scope 3: Methane* emissions from landfilled waste. Data provided by the County.
- *Employee Commute – Scope 3:* Fuel consumption for employee commuting. Data provided by the County.

The inventory was conducted primarily using ICF's proprietary Greenhouse Gas Inventory Database (GHG:ID) tool and supplemented with additional emissions calculations. This tool is designed to assist clients develop a transparent GHG inventory that conforms to widely accepted protocols and provides information required to form corporate GHG strategy. For Los Angeles County municipal operations, the tool was modified to include landfill waste, wastewater treatment plants, waste generation, and water consumption.

4. Inventory Results

This section presents the 2009 GHG emissions inventory for the Los Angeles County Municipal operations, including the data collection and calculation methodology for each sector. The results of the municipal inventory for 2009 in metric tons of carbon dioxide equivalent ($MTCO_2e$) are presented in Table 1 and Figures 1, 2, and 3 above. Each section below describes a different sector of the inventory. Introductory information for each sector is followed by data acquisition and sources, emission calculations and methodologies, data gaps, and emissions.

4.1 Building Energy Use

Building energy use from municipal buildings is a significant component of the County's GHG inventory, accounting for 20 percent of the County's total emissions in 2009. This sector includes any emissions from building energy use in County-owned or operated facilities, including leased facilities. Energy consumption includes electricity and natural gas usage. Electricity use can result in indirect emissions occurring at the power plants outside the County jurisdiction which produce the electricity, and is classified as Scope 2 emissions. Natural gas consumption results in direct emissions through the combustion process occurring where the natural gas is combusted, and is classified as Scope 1 emissions.

4.1.1 Data Acquisition and Sources

The County obtains electricity from six different utilities (Southern California Edison, Los Angeles Department of Water and Power, Pasadena Water and Power, Burbank Water and Power, Glendale Water and Power, and Azusa Light and Water). Electricity data was obtained from utility bills and aggregated to the utility-wide level in the 2009 CCAR report[3]. The County obtains natural gas from three different sources (Southern California Gas Company, Long Beach Gas & Oil Department, and the State of California Department of General Services). Natural gas data was also obtained from the 2009 CCAR report, aggregated to the utility-wide level. Table 3 presents County building energy use for each utility.

[3] The County joined the California Climate Action Registry to assist the County in establishing goals for reduction of the greenhouse gases, developing measurement processes, and reporting results through the Energy and Environmental Team to the Board of Supervisors.

4.1.2 Emissions Calculations / Methodologies

Electricity and natural gas consumption quantities were multiplied by utility-specific emission factors presented in Table 2 to determine GHG emissions. The emission factors for electricity consumption for each utility represent all emissions related to electricity deliveries (including owned and purchased power) for 2009 (CCAR 2009).[4] The utility specific emission factors were used to calculate emissions from electricity consumption for all electrical utilities, except for Azusa Light and Water whose emission factor was not publically available so the EPA eGrid emission factor for the CAMX region was used instead (USEPA 2010a).

Table 3. 2009 Building Energy Use

Utility	Electricity (kWh)	Natural Gas (therms)
Southern California Edison[1]	489,628,373	-
Los Angeles Department of Water & Power[2]	345,062,806	-
Pasadena Water & Power	18,256,155	-
Glendale Water & Power	1,456,997	-
Burbank Water & Power	1,084,102	-
Azusa Water & Light	167,490	-
Southern California Gas Company	-	11,154,011
Long Beach Gas & Oil Department	-	124,343
State of CA Department of General Services[3]	-	12,403,182
Total	855,655,923	23,681,536

[1] Water pump electricity use (33,244,470 kWh), wastewater treatment plant electricity use (628,139 kWh), cogeneration plant electricity use (2,570,000 kWh) was subtracted from the total SCE electricity use (526,070,982 kWh) to avoid double-counting emissions.

[2] Cogeneration plant electricity use (3,406,000 kWh) was subtracted from the total LADWP electricity use (348,468,806 kWh) to avoid double-counting emissions.

[3] Cogeneration plant natural gas use (36,854,880 therms) was subtracted from the total natural gas use (49,258,062 therms) to avoid double-counting emissions with the cogeneration sector.

[4] The emission factor varies from year to year due to a variety of factors that influence a utility's ratio of owned to purchased power and the source of generation (natural gas, hydroelectric, coal, etc.). The emission factor is higher in years when a utility purchases more power to meet California electricity demand. Thus, the emission factor for any given year can vary and also varies widely by utility company (CCAR 2009).

4.1.3 Data Gaps

Electricity and natural gas data from the CCAR report was aggregated by utility and was not separated by facility or department. However, as described below, an accurate breakdown of energy use by facility and department would help to make this inventory more comprehensive and robust and would assist the County in identifying effective energy efficiency measures for specific departments or facilities. In addition, the aggregation of energy use by utility means that energy use for activities contained in other sectors of this inventory, including electricity and natural gas used for water-related purposes (water pumping and distribution), wastewater treatment, and cogeneration facilities, are likely included in the CCAR data. As such, water pumping and cogeneration energy use was subtracted from the utility energy use to avoid double-counting.

ICF received a summary of electricity use by department from the County. However, the total electricity use provided in this report was about 35 million kWh less than the data obtained from the County's CCAR report. Additionally the departmental totals varied significantly from those provided by the County's utility companies. It is possible that the utility companies calculate the departmental totals differently than the County – the County's data included significantly more departments than the departments in the utility data so the utilities may simply be aggregating the County's departments. ICF will be reviewing these two sets of data to reconcile this discrepancy.

Based on data obtained from the County, a building database has been created that contains various characteristics of the County's buildings. This database contains the following items, for each County building:

1. Database ID number
2. Facility Name
3. Facility Address
4. Gross and Net Square Footage
5. Year Built
6. Building Use / Type
7. Date building was last modified / retrofitted
8. Utility company (water, gas, electricity)
9. Employee Count
10. Floors (below and above ground)
11. Operating hours

This database will be used in the analysis of the County's building portfolio for the County's greenhouse gas reduction plan.

4.1.4 Building Energy Use Emissions

Table 4 presents building energy use emissions for the County.

Table 4. 2009 Building Energy Use Emissions

Utility	GHG Emissions ($MTCO_2e$)			
	CO_2	CH_4	N_2O	CO_2e
Southern California Edison	140,117	144.0	607.1	140,868
Los Angeles Department of Water & Power	192,186	101.4	427.9	192,716
Pasadena Water & Power	13,780	5.4	22.6	13,808
Glendale Water & Power	704	0.4	1.8	706
Burbank Water & Power	539	0.3	1.3	541
Azusa Water & Light	55	0.0	0.2	55
Southern California Gas Company	62,724	123.6	36.5	62,884
Long Beach Gas & Oil Department	699	1.4	0.4	701
State of CA Department of General Services[1]	69,749	137.4	40.6	69,927
Total	480,554	513.9	1,138.5	482,206

4.2 Cogeneration Facilities

The County operates three cogeneration plants: Pitchess, Civic Center, and Olive View. The Pitchess Cogeneration Station sells power to SCE and delivers thermal energy (steam) to the Pitchess Detention Center. The Civic Center Cogeneration Plant sells power to Los Angeles DWP and delivers thermal energy (steam and chilled water) to the Los Angeles Civic Center (including some non-County tenants). The Olive View Power Plant provides electricity and hot water to the Olive View – UCLA Medical Center and sells excess power to the Los Angeles DWP.

Greenhouse gas emissions from these three cogeneration plants account for approximately 8.6% of the County's total emissions in 2009. These emissions result from natural gas combustion with the resultant emissions characterized as Scope 1. In addition, some electricity is purchased with the resultant emissions characterized as Scope 2.

4.2.1 Data Acquisition and Sources

Several reports are available to determine natural gas consumption, electricity production, electricity purchases, electricity sales, and thermal energy production for the plants. Reports include Forms CEC-1304 submitted each year to the California Energy Commission, and internal reports that summarize monthly and annual energy balances. This data allows for calculating direct and indirect emissions of greenhouse gases, and allocating greenhouse gas emissions between electricity generation and thermal energy generation.

Natural gas consumed at the power plants is reported on the Forms CEC-1304 Schedule 2 Part A. Natural gas consumed at the power plants is included within the non-core accounts on utility bills.

Electricity production and distribution is reported on the Forms CEC-1304 Schedule 2 Part B. The gross power production is the total of all columns. Net production is determined by subtracting the plant auxiliary. Net production includes power used at the plant itself (onsite use), at the supported facility (e.g. detention center, civic center, or hospital), and resale to the utility. In addition, the electricity purchased from the utility is shown on the internal reports and is included in utility bills provided by SCE (Pitchess) and DWP (Civic Center and Olive View).

4.2.2 Emissions Calculations / Methodologies

Greenhouse gas emissions due to natural gas consumption (3,685,488 MMBtu) are calculated using default emission factors for stationary natural gas consumption as presented in Table 2 above (0.0533 MT CO_2e/GJ). Indirect greenhouse gas emissions due to electricity purchases (5,976 MWh) are calculated using utility-specific emission factors for electricity consumption (see Table 2). The Scope 2 emissions due to electricity purchases are small in comparison with the Scope 1 emissions. The Scope 1 emissions were 207,252 MTCO_2e and the Scope 2 emissions were 1,960 MT CO2e for net generation of 338,766 MWh electricity. The County sold 288,296 MWh to SCE and LADWP.

4.2.3 Data Gaps

Natural gas consumption used in deriving Scope 1 emissions for the cogeneration plants is metered (derived directly from each plant), so the calculation methodology does not need improvement. Scope 2 emissions could be broken out separately but are trivial in comparison. Factors used for calculation of Scope 2 emissions will vary as SCE and LADWP issue new annual reports and depend on the mix of electricity sources for the utilities.

4.2.4 Cogeneration Facility Emissions

Table 5 presents emissions from Cogeneration facilities owned and operated by the County in 2009 as a result of natural gas and electricity consumption.

Table 5. 2009 Cogeneration Facility Energy Consumption and Emissions

Facility	Natural Gas (therms)	Electricity (therms)	GHG Emissions ($MTCO_2e$)			
			CO_2	CH_4	N_2O	CO_2e
Pitchess[1]	18,074,440	2,570,000	735	0.8	4.2	740
Civic Center	15,682,370	3,406,000	1,897	1.0	3.2	1,901
Olive View	3,098,070	-	207,252	408.3	120.5	207,781
Total	36,854,880	36,854,880	209,885	410.0	128.0	210,423

[1] Electricity supplied by SCE.

[2] Electricity supplied by LADWP.

4.3 Vehicle Fleet

Vehicle fleet emissions for vehicles owned and operated by the County account for approximately 5.3 percent of the County's total Municipal emissions in 2009. These emissions are direct Scope 1 emissions resulting from the vehicle fuel combustion. The County owns thousands of vehicles and thus this sector of the inventory is a significant portion of the County's overall GHG emissions. County vehicles include passenger cars, motorcycles, SUVs, vans, firefighting equipment, offroad vehicles, and many others. The departments with large vehicle fleets include public works, sheriff, fire, internal services, and parks.

4.3.1 Data Acquisition and Sources

Fuel consumption data for vehicle fleets for the County's 35 departments were obtained from the County Internal Services Department. Fleet profile information was also obtained from each major fleet department, but fuel consumption by vehicle was not available.

4.3.2 Emissions Calculations / Methodologies

Emissions from this source were estimated by multiplying fuel consumption by the appropriate emission factors presented in Table 2 to determine GHG emissions. The County also owns transit vehicles which are operated by a

contractor. Fuel consumption data for these transit vehicles was obtained from the County, and associated emissions were calculated using emission factors presented in Table 2.

4.3.3 Data Gaps

Although, fuel consumption data for County fleets collected for this report represents at least 95% of fuel consumed by County vehicles, there are a few areas for improvement in the Vehicle fleet data. Specifically, additional fuel was purchased using company credit cards and Voyager accounts and consumed on County business, but the County does not currently have a tracking system for these purchases. Although fleet profile information was available for the largest County vehicle fleets, fuel consumption by vehicle was not available. This data would help the County indentify reduction measures more accurately, as specific vehicles could be targeted for replacement. In addition, 2008 fuel consumption for transit vehicles operated by the department of Public Works is included in this inventorybecause 2009 data was not available. Lastly, the County has contracts with third-party vehicle operators which include seasonal dump trucks, street sweepers, refuse hauling vehicles, and tree-trimming vehicles. Fuel consumption data for these contracted vehicles was not available.

4.3.4 Vehicle Fleet Emissions

The County vehicles consume a wide range of fuels, including diesel, gasoline, E-85, jet fuel, aviation gasoline, marine fuel, propane/liquefied petroleum gas (LPG), and compressed natural gas (CNG). Table 6 presents fuel consumption by fleet for each department. Table 6 presents County fleet GHG emissions for each department.

Table 6. 2009 Vehicle Fleet Fuel Consumption by Department

Fleet Department	Fuel Consumption							
	Diesel (gal)	Gasoline (gal)	E-85 (gal)	Jet Fuel (gal)	Aviation F (gal)	Marine Fuel (gal)	Propane/ LPG (GGE)[1]	CNG (GGE)[1]
County Departments								
Agricultural Com	1,433	180,930	-	-	37	-	-	44
Animal Care	227	111,376	-	-	-	-	-	466
Assessors	0	546	-	-	-	-	-	-
Beaches & Harbors	61,448	113,917	-	-	-	50	-	-
Board of Supervisors	0	3,572	-	-	-	-	-	-
CEO	0	473	-	-	-	-	-	-
Child Support Services	0	4,088	-	-	-	-	-	-
Children's Med Services	0	1,819	-	-	-	-	-	-
Children's & Family Svs.	0	53,601	-	-	-	-	-	-
Community & Senior	0	3,295	-	-	-	-	-	-

Fleet Department	Fuel Consumption							
	Diesel (gal)	Gasoline (gal)	E-85 (gal)	Jet Fuel (gal)	Aviation F (gal)	Marine Fuel (gal)	Propane/ LPG (GGE)[1]	CNG (GGE)[1]
Coroner's	601	47,178	-	-	-	-	-	-
County Council	0	14	-	-	-	-	-	-
District Attorney	32	163,779	-	-	32	-	-	92
DPSS	-	17	-	-	-	-	-	-
Fire Department	1,355,391	366,049	-	353,565	-	20,800	37,835	-
Harbor UCLA Med Ctr	534	14,166	-	-	-	-	-	682
Health Services	82	461	-	-	-	-	-	1,272
High Desert Hospital	-	17,443	-	-	-	-	-	-
ISD	70,264	1,135,199	-	-	-	-	-	1,088
King Drew Med Ctr.	72	13,330	-	-	-	-	-	2,276
LAC/USC	-	2,871	-	-	-	-	-	6,637
Mental Health	-	9,329	-	-	-	-	-	-
Museum of Natural History	104	2,196	-	-	-	-	-	-
Office of Public Safety	1,289	205,441	-	-	69	-	-	-
Olive View Med. Ctr.	995	15,504	-	-	-	-	-	1,156
Parks & Rec.	19,294	324,631	-	-	-	-	-	-
Probation	26	52,906	-	-	16	-	141,215	-
Public Library	1,294	40,551	-	-	-	-	0	976
Public Works	667,595	1,519,314	-	-	-	-	96,456	10,510
Register Recorder	619	11,645	-	-	-	-	-	10
Sanitation	5,699	85,220	-	-	-	-	-	-
Sheriff's	566,927	4,855,695	104	669,934	10,045	3,517	1,504	6,609
Superior Court	-	982	-	-	-	-	-	-
Treasurer & Tax	-	1,370	-	-	-	-	-	-
Warm Springs/Acton Rehab	-	18,483	-	-	-	-	62,652	-
Total Fleet Department	2,753,925	9,377,391	104	1,023,499	10,199	24,367	339,662	31,818
Transit Services								
ELA DAR	-	13,529	-	-	-	-	-	-
Whitter DAR	-	20,038	-	-	-	-	5,576	-
Willowbrook DAR	-	9,002	-	-	-	-	-	-
Hahn's Trolley	4,064	16,562	-	-	-	-	-	-
Rosewood Shuttle	-	1,862	-	-	-	-	12,016	-
Sunshine Shuttle	-	-	-	-	-	-	46,582	-
East Valinda Shuttle	-	8,496	-	-	-	-	-	-
Avocado Heights/Bassett/West Valinda Shuttle	-	7,515	-	-	-	-	-	-
El Sol Shuttle	-	346	-	-	-	-	115,949	-

Fleet Department	Fuel Consumption							
	Diesel (gal)	Gasoline (gal)	E-85 (gal)	Jet Fuel (gal)	Aviation F (gal)	Marine Fuel (gal)	Propane/ LPG (GGE)[1]	CNG (GGE)[1]
Acton-Agua Dulce Shuttle	-	-	-	-	-	-	3,411	-
Department of Public Works[2]	3,420	41,034	-	-	-	-	141,558	-
Total Transit Services	7,484	118,385	0	0	0	0	325,093	0
GrandTotal	2,753,925	9,377,391	104	1,023,499	10,199	24,367	339,662	31,818

1. GGE = gallons of gasoline equivalent.
2. Year 2008 data

Table 7. 2009 Vehicle Fleet GHG Emissions by Department

Department	GHG Emissions (MT)			
	CO_2	CH_4	N_2O	CO_2e
County Departments				
Agricultural Com	1,604	0.5	11.3	1,616
Animal Care	983	0.7	7.4	991
Assessors	5	0.0	0.0	5
Beaches & Harbors	1,628	0.5	10.0	1,638
Board of Supervisors	31	0.0	0.2	32
CEO	4	0.0	0.0	4
Child Support Services	36	0.0	0.3	36
Children's Med Services	16	0.0	0.1	16
Children's & Family Svs.	471	0.1	3.3	474
Community & Senior	29	0.0	0.2	29
Coroner's	420	0.1	3.0	423
County Council	0	0.0	0.0	0
District Attorney	1,439	0.5	10.3	1,450
DPSS	0	0.0	0.0	0
Fire Department	22,229	11.5	179.5	22,420
Harbor UCLA Med Ctr	134	0.6	1.7	137
Health Services	14	1.1	1.4	16
High Desert Hospital	153	0.0	1.1	154
ISD	10,688	4.2	74.8	10,767
King Drew Med Ctr.	133	1.9	3.3	139
LAC/USC	71	5.6	7.5	84
Mental Health	82	0.0	0.6	83
Museum of Natural History	20	0.0	0.1	20
Office of Public Safety	1,817	0.6	12.8	1,831
Olive View Med. Ctr.	154	1.0	2.3	157

Department	GHG Emissions (MT)			
	CO_2	CH_4	N_2O	CO_2e
Parks & Rec.	3,046	0.9	21.0	3,068
Probation	1,708	4.6	178.3	1,891
Public Library	376	0.9	3.6	380
Public Works	21,036	18.1	256.4	21,311
Register Recorder	109	0.0	0.8	109
Sanitation	806	0.3	5.5	812
Sheriff's	55,201	26.4	403.5	55,631
Superior Court	9	0.0	0.1	9
Treasurer & Tax	12	0.0	0.1	12
Warm Springs/Acton Rehab	714	2.0	78.8	795
Total Fleet Department	125,178	82.6	1,279.4	126,540
Transit Services				
ELA DAR	119	0.0	0.8	120
Whitter DAR	225	0.2	8.2	233
Willowbrook DAR	79	0.0	0.6	80
Hahn's Trolley	187	0.1	1.2	188
Rosewood Shuttle	122	0.4	15.0	137
Sunshine Shuttle	410	1.5	57.7	469
East Valinda Shuttle	75	0.0	0.5	75
Avocado Heights/Bassett/West Valinda Shuttle	66	0.0	0.5	66
El Sol Shuttle	1,023	3.7	143.8	1,171
Acton-Agua Dulce Shuttle	30	0.1	4.2	34
Department of Public Works	395	0.1	2.7	398
Total Transit Services	2,731	6.2	235.2	2,972
GrandTotal	127,909	88.8	1,514.6	129,512

4.4 Owned Landfills

The County owns and or operates eleven landfills, several of which are closed. Landfills and their current status (i.e., open or closed) are listed in Table 8. The emissions from all of these landfills, even closed, are included in the inventory. Organic waste that is buried in landfills decomposes under anaerobic conditions to produce methane (CH_4). CH_4 is a GHG with a global warming potential that is 21 times that of CO_2. Although waste deposited in landfills owned and operated by the County may originate from jurisdictions other than The County, because the County has full jurisdictional control over these landfills, associated emissions are included in the County's baseline GHG inventory. As such, landfill emissions are a Scope 1 inventory item. The decomposition of waste and consequent release of CH_4 continues for many years after waste is deposited.

CH_4 emissions for each landfill in 2009 are listed in Table 8. Total emissions from landfills under the jurisdictional control of the County are 1,129,157 metric tons CO_2e for the baseline year 2009. Landfill emissions represent 46.3% of the County's total GHG emissions. Because landfills operated by the County accept waste from many jurisdictions, landfill related emissions are largely un-related to County-wide population, waste generated by County municipal facilities and/or behavioral or regulatory changes related to waste generation that happen within the County.

4.4.1 Data Acquisition and Sources

In 2009, the California ARB conducted a study to examine the methane reduction potential of proposed landfill regulation (CARB, 2009). The report contains data on the majority of landfills within the state including: open year, closing year, 1990 waste in place (WIP), 2006 WIP and estimated 2020 WIP. Additionally the report identifies the control technologies installed at each landfill. The CARB's report was the sole source of landfill related data. The County confirmed the specific landfills that fall under their jurisdictional control (pers. Comm. Linda Lee, 2010). All of these landfills are listed in the CARB study.

4.4.2 Emissions Calculations / Methodologies

The CARB's First Order Decay (FOD) model was used to estimate CH_4 emissions from landfills (CARB, 2010). This is a standard Excel based model that is consistent with IPCC recommended methodologies for estimating waste decay rate, CH_4 and CO_2 emissions. The model requires the following inputs: year of opening, year of closing, annual waste deposition and local annual precipitation rate. Specific landfill data from the CARB's landfill report (CARB, 2009) was input into the model, resulting in 11 unique model runs. For landfills listed as having methane capture or flaring technologies installed, a default methane destruction efficiency of 75% was assumed.

4.4.3 Data Gaps

Site-specific landfill methane capture rates would improve this sector of the inventory. Landfill emissions are based on the consolidated landfill report prepared by the ARB. This report contained waste in place information for all landfills owned and operated by the County. Although individual, landfill operators may collect data on-site related to the maintenance and operation of gas flaring systems, this data is not always sufficient to estimate precise methane destruction efficiency. This information was not included in the summary report prepared by the ARB in 2009, the primary data source for this sector (CARB, 2009). Individual landfill operators were not contacted for the purposes of data collection.

4.4.4 Owned Landfill Emissions

Table 8 presents each landfill owned and operated by the County, whether the landfill is opened or closed, the amount of waste-in-place at the landfill in 2009, and the associated CH_4 emissions.

Table 8. Data and 2009 Emissions for Landfills Owned and Operated by the County

Landfill Name	Open/Closed	2009 Waste in Place (tons)[1]	CH_4 Emissions (MT)	CO_2e Emissions (MT)
Blanchard St. Dump (19-AA-0580)	Closed	250,000	85	1,788
BKK Carson (19-AQ-0005)	Closed	500,000	212	4,456
BKK Carson (19-AQ-0014)	Closed	500,000	212	4,456
Puente Hills (19-AA-0053)	Open	171,819,851	28,849	605,823
Scholl Canyon (19-AA-0012)	Open	32,942,702	5,698	119,650
Calabasas (19-AA-0056)	Open	23,977,763	4,147	87,089
Palos Verdes (19-AE-0001)	Closed	23,600,000	3,243	68,099
Mission Canyon (19-AA-0821)	Closed	26,800,000	3,755	78,857
Mission Canyon (19-AA-0822)	Closed	26,800,000	3,755	78,857
Mission Canyon (19-AA-0823)	Closed	26,800,000	3,755	78,857
Pitchess Detention Center (19-AA-0057)	Closed	75,000	58	1,225
Total	N/A	334,065,316	53,769	1,129,157

[1] Waste in place for 2009 for closed landfills was assumed to be the value in place at time of closing (CARB, 2009). For open landfills, the 2009 value was estimated based on the full capacity of the landfill and the amount of waste in place in 2006, as provided by the CARB (CARB 2009).

Sources: CARB 2009; CARB 2010.

4.5 Refrigerants

Fugitive emissions from refrigerants account for approximately 0.01 percent of The County's 2009 municipal inventory. Fugitive emissions are Scope 1 emissions and include high-GWP gases used as substitutes for ozone depleting substances (ODS) (primarily hydrofluorocarbons [HFCs] and perfluorocarbons [PFCs]) in refrigeration and air conditioning units in both fleets and buildings. HFCs and PFs are Kyoto Protocol gases. These high-GWP gases are emitted during normal use in appliances, as well as leakage from appliance disposal.

A number of other refrigerants, which have high GWPs, including Freon (R-22), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are also used in refrigeration and air conditioning units. However, these substances are classified as ODS and are currently being phased out under the Montreal Protocol. Although these gases do have a global warming impact, based on guidance provided by the ARB, emissions from ODS were therefore not included in the emissions inventory (CARB et. al. 2010).

The following refrigerants are used in County buildings and vehicle refrigerant systems and are included in the inventory in accordance with the LGOP: R-113, R-401A, R-404A, R-410A, R-414B, R-500, R-5002, R-507, R-507a, R-408A, and HFC-134a.

4.5.1 Data Acquisition and Sources

Fleet refrigerant data was acquired through personal communications with the County's Internal Services Department. Building-related (appliances, air conditioning, etc.) refrigerant data was provided for County facilities managed by General Services. This data was also acquired from the County's Internal Services Department.

4.5.2 Emissions Calculations / Methodologies

The ARB's *Local Government Operations Protocol* (LGOP) Version 1.1 (California Air Resources Board et. al. 2010:61-63) was used to quantify emissions of HFCs and PFCs. Information on refrigeration and air conditioning units owned and operated by the County, including the types of refrigerants and refrigerant charge capacities for each piece of equipment, was based on a 2009 appliance inventory provided by the County.

The LGOP provides default emission factors for the installation, operation, and removal of six common types of refrigeration and air conditioning systems: domestic refrigeration, stand-alone commercial applications, medium & large commercial refrigeration, industrial refrigeration (including food processing and cold storage), chillers, and residential and commercial A/C units (including heating pumps)[5]. Based on the descriptions of these systems, equipment included in the 2009 County inventory were grouped into one of the six categories, and annual emissions for each type of refrigerant estimated using the following equation[6]:

$$E = [(C * X * T) + (C_d * Y * (1-Z))] / 1{,}000$$

Where

[5] See Table 6.4 in the LGOP.

[6] Equation omits the installation emissions factor because it was assumed that no new equipment was installed during 2009

E = Emissions (metric tons per year)
C = Total full charge (capacity) of the equipment in kilograms (kg)
X = Operating emission factor (see Table 6.4 in the LGOP)
T = Time in years equipment was in use (assumed to be 1 year)
C_d = Total full charge (capacity) of the equipment being disposed in kg
Y = Percent of refrigerate remaining at disposal (see Table 6.4 in the LGOP)[7]
Z = Percent of recovery efficiency (see Table 6.4 in the LGOP)[2]

The equipment charges (C and C_d) were based on information provided in the 2009 County appliance inventory. In cases where the refrigerant charge capacity was unknown for a piece of equipment, the upper bound of the default range provided in Table 6.4 of the LGOP was used to provide a conservative estimate of fugitive emissions from these equipment.

The 2009 County inventory listed equipment pieces as either "operational" or "disposed". For those systems identified as "operational", only those emissions associated with equipment operations (X) were estimated (i.e. the disposal (Y) and recovery (Z) factors were omitted from the equation above). For each piece of equipment identified as "disposed", all factors included in the above equation were applied to estimate annual emissions. To be conservative, the operational emissions factor is included for pieces were disposed in 2009, even though they may have been disposed at the beginning of the year.

Once total annual emissions for each type of refrigerant were quantified, the appropriate global warming factor was applied to convert each HFC or PFC to units of CO_2e (Table 9). It should be noted that the emissions summarized in Table 9 may overestimate actual fugitive emissions from refrigerants. This is because the default emission factors and charge capacities (as appropriate) used in the analysis were based on the most conservative range recommended by the IPCC (California Air Resources Board et. al. 2010:62). A more refined account of emissions could be realized if information on the purchase and sale of HFCs and PFCs were available so that direct amounts of refrigerant leakage could be calculated using the "mass-balance" method recommended by the LGOP (instead of using default emission factors for the installation, operation, and removal of equipment as described above).

Refrigerant emissions from fleets were calculated using total refrigerant charge for County vehicles and a standard leakage rate of 11%. Total refrigerant emissions were calculated by multiplying the sum of the refrigerant leakage (by refrigerant type) by the global warming potential (GWP) of the refrigerant blend or gas. These GWPs are in tables E.1 and E.2 of the LGOP (CARB et. al. 2010).

[7] Factors were only applied to those pieces of equipment disposed of during 2009

4.5.3 Data Gaps

Refrigerant emissions from buildings are for General Services-managed buildings only. It is possible that there are County facilities that are not managed by General Services; if this is the case, not all refrigerant emissions are accounted for in this inventory. In addition, fleet refrigerant use/charge was provided on an aggregated level and it is therefore difficult to assess if this data is complete. A complete data set of all County-owned and operated appliances and equipment which use refrigerants would improve the estimate of emissions from refrigerants in this inventory and assist the County in identifying effective GHG reduction measures in this sector.

4.5.4 Refrigerant Emissions

Table 9 presents fugitive emissions from refrigerants in 2009 for County buildings and fleets.

Table 9. 2009 Fugitive Refrigerant Emissions

Refrigerant[1]	GWP	Emissions ($MTCO_2e$)
R-113	5,000	816.5
R-401A	18	0.2
R-404A	3,260	2,315.7
R-410A	1,725	310.8
R-414B	0	18.0
R-500	37	0.0
R-502	0	45.3
R-507	3,300	0.0
R-507A	3,300	0.2
HFC-134a[2]	1,300	0.1
Total	NA	3,506.7

[1] Excludes emissions from ozone depleting substances.
[2] Includes emissions from buildings (82.05) and fleets (228.77).

4.6 Miscellaneous (Ammunition, Ethylene Oxide, CO2, and Acetylene)

The County also uses ammunition, ethylene oxide, compressed CO_2, and acetylene in certain operations that result in GHG emissions. These emissions were combined and termed "miscellaneous" because they are relatively small. The Sheriff's department emissions result from ammunition discharges in training and operational activities. Ammunition discharges result in small amounts of CO_2 and CH_4 emissions. Ethylene oxide is used in hospitals for

sterilization. Emissions control equipment burns ethylene oxide on completion of the sterilization cycle. Compressed CO_2 is used in various County facilities, including hospitals. Acetylene, or welding gas, is used by County maintenance staff and for various applications. Total GHG emissions due to ammunition, ethylene oxide, and acetylene use were 2,201 metric tons of CO_2e in 2009. This is 0.1% of the County's total emissions in 2009.

4.6.1 Data Acquisition and Sources

Data on ammunition discharge, ethylene oxide use, and acetylene use was provided by the County in their 2009 CCAR report. Information was provided in units of rounds of ammunition, grams per day of ethylene oxide (according to the CCAR report, this value is 600 grams per day), and cubic feet of CO_2 and acetylene.

4.6.2 Emissions Calculations / Methodologies

Total rounds of ammunition were multiplied by the emission factors presented in Table 2. Ethylene oxide emissions were calculated by multiplying kg of ethylene oxide by 2, as oxidation of two molecules of ethylene oxide yields 4 molecules of CO2. Total cubic feet of CO2 consumed was converted to metric tons of CO2 using conversion factors (12.36 lbs/ft3 and 2,204.6 lbs/metric ton), and total cubic feet of acetylene was converted to cubic meters (35.3 ft3/m3) and multiplied by the emission factor for acetylene presented in Table 2.

4.6.3 Data Gaps

Reporting emissions by County facility or department would help make this inventory sector more comprehensive and detailed and would assist the County in identifying effective GHG reduction measures. No additional data gaps were identified.

4.6.4 Miscellaneous Emissions

Table 10 presents rounds of ammunition discharged, cubic feet of ethylene oxide used, and cubic feet of acetylene used on 2009 by the County. The table also presents CO_2, CH_4, and CO_2e emissions from these sources.

Table 10. 2009 Miscellaneous Emissions

Category	Use	GHG Emissions ($MTCO_2e$)[1]		
		CH_4	CO_2	CO_2e
Ammunition	Rounds			
9MM	4,555,250	0.061	0.413	0.474

Category	Use	GHG Emissions ($MTCO_2e$)[1]		
		CH_4	CO_2	CO_2e
38 Special	385,000	0.003	0.037	0.039
45 Pistol	381,500	0.003	0.038	0.041
223 Rumination Rifle	433,000	0.002	0.015	0.017
308 Winchester Rifle	20,300	0.000	0.001	0.001
12 Gauge Shotgun	471,665	0.058	0.278	0.337
Ethylene Oxide	Kilograms			
	219	-	0.22	0.44
CO_2	Cubic feet			
	391,963	-	2,197.63	2,197.63
Acetylene	Cubic feet			
	20,746	-	2.16	2.16
Total	N/A	0.127	2,200.79	2,201.14

4.7 Wastewater Treatment Plants

The County owns and operates four wastewater treatment plants (WWTPs). GHG emissions result from electricity and/or natural gas used to power the facilities. These emissions are classified as Scope 2 and are included in the inventory. Additional emissions of CH_4 and N_2O result from the treatment and breakdown of waste within the facility. These are commonly referred to as "fugitive emissions" and are classified as Scope 1 emissions. These are included in the inventory. Although some facilities capture the fugitive emissions (biogas) on site and use it for local power, this is not the case for the WWTPs operated by the County; therefore, all fugitive emissions are included in the inventory.

GHG emissions due to electricity consumption by WWTPs and fugitive emissions at these facilities are listed in Table 11. Total GHG emissions in 2009 due to wastewater treatment by County facilities was 1,295 metric tons of CO_2e. These emissions represent 0.1 % of the County's total emissions and are dominated by the fugitive emissions.

4.7.1 Data Acquisition and Sources

Annual electricity use for the four plants was provided by the Department of Public Works (DPW) (pers. Comm., Lana Radle, 2010). For each WWTP, DPW also provided: daily influent flow, population served, average nitrogen load and biochemical oxygen demand (BOD_5) load (pers. comm., Lana Radle, 2010). The County confirmed that all facilities are powered exclusively by electricity and that none of these facilities are capturing and using biogas.

4.7.2 Emissions Calculations / Methodologies

Electricity emission factors for the CAMX/WECC California region were used to calculate GHG emissions associated with electricity usage by WWTPs (see Table 2). Equation 10.3 and 10.4 in CARB's Local Government's Operating Protocol (CARB et. al. 2010) were used to estimate fugitive emissions of CH_4 and N_2O due to wastewater treatment. These equations require the following inputs: daily influent flow, population served, average nitrogen load and BOD_5 load. These equations are standard equations recommended for use by local governments in preparing GHG inventories and consistent with methodologies use for national and state level inventories.

4.7.3 Data Gaps

All emissions associated with wastewater treatment for the four plants operated by DPW are accounted for in the inventory. The County has jurisdictional control over an additional seven WWTPs and these facilities are operated by departments other than DPW. ICF has requested information on these WWTPs and will update the inventory to reflect emissions that result from operation of these WWTPs at a later date.

4.7.4 Wastewater Treatment Plant Emissions

Table 11 presents GHG emissions from wastewater treatment plants owned and operated by the County.

Table 11. 2009 Wastewater Treatment Plant Emissions

Wastewater Treatment Plant	GHG Emissions ($MTCO_2e$)			
	Electricity	Fugitive CH_4	Fugitive N_2O	Total
Malibu Mesa Water Reclamation Plant	3.0	602.9	8.6	614.5
Malibu Water Pollution Control Plant	1.7	128.0	2.3	132.0
Trancas Water Pollution Control Plant	164.1	212.2	1.0	377.4
Lake Hughes Community Water Treatment Facility	38.2	132.5	0.6	171.2
Total	207.0	1,075.6	12.5	1,295.1

4.8 Streetlights and Traffic Signals

Greenhouse gas emissions from streetlights and traffic signals owned and operated by the County account for approximately 0.1% percent of the County's total emissions in 2009. These emissions comprise electricity-related

consumption with the resultant emissions characterized as Scope 2. Electricity use results in indirect emissions occurring at the power plants which produce the electricity.

4.8.1 Data Acquisition and Sources

Electricity consumption data was obtained from the County's Traffic and Lighting Division. There are approximately 120,000 street lights and 116 traffic signals owned and operated by the County. The County provided a list of all streetlights which included information for two different monthly consumption and rate structures. The County also provided a list of all traffic signals which included monthly electricity consumption and spend information as well as respective addresses of the traffic signals.

4.8.2 Emissions Calculations / Methodologies

As discussed above, street light data consisted of light fixtures at different addresses broken out by the type of light, wattage and lumens. This information was then matched to SCE's rate structure sheets which provided approximate monthly usage and costs according to the type of lights. The assumption was made that usage and costs were consistent over a 12 month period, i.e. for the entirety of 2009. The usage was then applied by SCE's electricity emissions factor (as reported in CCAR) to yield approximate CO_2e emissions.

Table 12 presents streetlight and traffic signal energy use and resultant CO_2e emissions for The County. Streetlights consumed 78,563,064 kWh of electricity based on the type of light and the wattage provided by the County. Traffic signals consumed 6,125,824 kWh of electricity based on monthly records of these signals at specific addresses provided by The County. Approximately 99% of the streetlights and traffic signals are powered by Southern California Edison (SCE), with the remaining largely being powered by LADWP. SCE's emission factor as indicated in its 2007 CCAR report was applied to convert electricity usage (for those lights powered by SCE) from kWh to CO_2e; for lights powered by LADWP, the electricity emissions factor from its 2007 CCAR report was applied to those lights powered by LADWP. These calculations resulted in emissions estimates of 22,602.91 $MTCO_2e$ for streetlights and 1,767.3 $MTCO_2e$ for traffic signals.

4.8.3 Data Gaps

In the future, accuracy of streetlights electricity consumption could be improved by obtaining actual monthly electricity consumption numbers for each light rather than using an average electricity consumption number for each type of light under a specific rate class. While this latter approach was useful in estimating consumption, it does not allow for variations in terms of the actual duration of use across different types of lights for different addresses. Such a variation would allow a more rigorous analysis of how much energy was actually consumed, for the actual time

frame, and across different locations, resulting in a determination of which lights are being efficiently used and which ones are not.

4.8.4 Streetlight and Traffic Signal Energy Use Emissions

Table 12 presents GHG emissions from streetlights and traffic signals owned and operated by the County.

Table 12. 2009 Streetlight and Traffic Signal Energy Use and Emissions

Data/Emissions	Streetlights	Traffic signals	Total
Total Electricity Use (kWh)	78,563,064	6,125,824	84,688,888
Total Emissions ($MTCO_2e$)	22,603	1,767	24,370

4.9 Water Pumps

The County owns and operates a series of pumps used for pumping local groundwater, distributing both local and state water project (SWP) water, and moving storm-water. GHG emissions result from the electricity consumed to power these pumps. These emissions are classified as Scope 2 and are included in this inventory. These emissions are due to the County's role as a water provider, not as a water consumer. Total GHG emissions due to water pumping and distribution services provided by The County were 10,955 metric tons of CO_2e in 2009. This is 0.5% of the County's total emissions in 2009.

4.9.1 Data Acquisition and Sources

The County DPW provided a complete list of pumps and wells in the County and the annual electricity use for each pump (pers. Comm., Rea, Joseph-Gonzalez, 2010).

4.9.2 Emissions Calculations / Methodologies

Electricity emission factors for the CAMX/WECC California region were used to calculate GHG emissions associated with electricity usage by WWTPs (see Table 2).

4.9.3 Data Gaps

Emissions associated with the County's role as water provider have been fully accounted for. There are no data gaps for this aspect of the water sector.

4.9.4 Water Pump Emissions

Table 13 presents GHG emissions from water pumps owned and operated by the County.

Table 13. Water Pump Emissions

	Electricity (kWh)	GHG Emissions ($MTCO_2e$)			
		CO_2	CH_4	N_2O	CO_2e
Water Pumps	33,244,470	10,904	9.8	41.2	10,955
Total	33,244,470	10,904	9.8	41.2	10,955

4.10 Water Consumption

In addition to being a water provider, the County also functions as a water consumer. County buildings and facilities utilize water in faucets, toilets, hoses, sprinkler systems, washing machines, dishwashers and other uses. Electricity is used to deliver this water to County facilities. Emissions associated with the County municipal water consumption are classified as Scope 2, as they represent indirect emissions associated with electricity consumption.

County water consumption emissions account for approximately 0.6 percent of the County's total emissions in 2009. The County's water consumption includes the following indirect emissions: electricity consumption for water supply and conveyance, water treatment, water distribution, and wastewater treatment. These emissions do not include the water pumping electricity emissions sector described above (Scope 2), which includes electricity purchased by the County to operate water pumps owned and operated by the County. These water pumps supply the community at large, but do not supply County facilities with water. This sector includes the following:

- transporting water to the County Regions from other areas in the state (water supply and conveyance);
- treatment of water at facilities not owned by the County (water treatment);
- distributing this water to each County facility/department (water distribution); and
- treatment of wastewater at facilities not owned by the County (wastewater treatment).

4.10.1 Data Acquisition and Sources

All water consumption data for County each department was provided by the County's Internal Services Department.

4.10.2 Emissions Calculations / Methodologies

Methodologies for calculating emissions associated with County municipal water consumption, including water supply and conveyance, water treatment, water distribution, and wastewater treatment, are described below.

4.10.2.1 Water Supply and Conveyance

Water supply involves indirect emissions from the generation of electricity required to supply the County with water. The energy used to transport water to Southern California was obtained from the CEC 2006 report, *Refining Estimates of Water-Related Energy Use in California*, which provides proxies for embodied energy use for water in Southern and Northern California (CEC 2006b). The energy intensity associated with water supply and conveyance in Southern California is approximately 9,727 kWh/million gallons (MG) (CEC 2006b).

Information in the CEC report regarding electricity usage and loss factors, and imported water quantities provided by the County, was used to calculate indirect emissions from water importation to the County (CEC 2006b). Electricity emission factors for the CAMX/WECC California region were used to calculate GHG emissions (724.12 lbs CO_2/MWh, 30.24 lbs CH_4/GWh, and 8.08 lbs N_2O/GWh), since electricity used to transport water to County facilities is supplied by many utilities within this region.

4.10.2.2 Water Treatment

Before water is pumped to the County, it is purified by passing through various treatment processes. Since the County does not own or operate any water treatment plants, electricity consumed to treat water for County use is not included in the utility data provided above in the Facility Energy Use section. Since the County relies on this service, emissions associated with electricity consumed for water treatment processes were included in the inventory. The energy intensity for water treatment is approximately 111 kWh/acre-foot of water (CEC 2006b).

4.10.2.3 Water Distribution

Water distribution involves distributing water to end users within a region. The energy intensity in distribution is directly related to the distance and lift involved to transporting water from the conveyance terminus to the retail customers.

Although this electricity is consumed by other entities outside of County control, it is required to pump the water consumed at County facilities. Consequently, emissions associated with this electricity were included in the inventory. The energy intensity for water pumping is approximately 111 kWh/MG of water (CEC 2006b).

4.10.2.4 Wastewater Treatment

Wastewater treatment involves treating wastewater generated by County Facilities. Some of the County's wastewater may be treated in County owned wastewater treatment facilities. However, some wastewater may be treated in wastewater treatment that are not owned and operated by the County. To provide a conservative estimate of wastewater treatment electricity, it was assumed that all wastewater generated by County operations is treated in facilities not owned by the County. Although this electricity is consumed by other entities outside of County control, it is required to treat wastewater generated by County facilities. Consequently, emissions associated with this electricity were included in the inventory. The energy intensity for wastewater treatment is approximately 1,911 kWh/MG of water (CEC 2006b).

4.10.3 Data Gaps

The County of Los Angeles is served by numerous water districts, each with a different mix of water supplies (imported, groundwater, etc.) and potentially different electricity intensities for the four processes described above. Since water use was provided by department, and since County departments and facilities are located all over the County, the level of detail used in this inventory was not sufficient to match each gallon of water consumed with a specific water district. Consequently, Southern California average electricity intensity factors were used to estimate emissions from this sector. Water consumption by facility and information on the water district supplying water to each facility would improve the estimate of emissions in this sector.

In addition, it was assumed that County-owned and operated water pumps and wastewater treatment plants do not serve County facilities. If this is not the case, then some emissions in this sector may be double-counted with the *Water Pumps* and *Wastewater Treatment Plant* sectors above.

4.10.4 Water Consumption Emissions

Table 14 presents water consumption by department and the emissions associated with water supply and conveyance, water treatment, water distribution, and wastewater treatment.

Table 14. 2009 Water Consumption and GHG Emissions by Department

Department	Water Consumption (gallons)	GHG Emissions ($MTCO_2e$)				
		Water Supply and Conveyance	Water Treatment	Water Distribution	Wastewater Treatment	Total
Affirmative Action Commission	412,925	1.30	0.01	0.17	0.20	1.69
Agricultural Comm/Weights & Measures	7,701,195	24.33	0.28	3.18	3.73	31.52
Alternate Public Pefender	3,520,332	11.12	0.13	1.45	1.70	14.41
Animal Care & Control	10,557,257	33.36	0.38	4.36	5.11	43.21
Assessor	18,725,984	59.17	0.68	7.74	9.07	76.65
Auditor-Controller	7,588,987	23.98	0.27	3.14	3.67	31.06
Beaches & Hharbors	37,689,849	119.09	1.36	15.57	18.25	154.27
Board of Supervisors	9,122,494	28.82	0.33	3.77	4.42	37.34
Chief Executive Office	18,167,190	57.40	0.66	7.51	8.80	74.36
Chief Information Office (1)	0	0.00	0.00	0.00	0.00	0.00
Children & Family Services	26,193,787	82.76	0.94	10.82	12.68	107.21
Community And Senior Services	11,356,177	35.88	0.41	4.69	5.50	46.48
Consumer Affairs	1,000,145	3.16	0.04	0.41	0.48	4.09
Coroner	293,236	0.93	0.01	0.12	0.14	1.20
County Counsel	4,836,904	15.28	0.17	2.00	2.34	19.80
District Attorney	31,659,055	100.03	1.14	13.08	15.33	129.58
Fire	97,110,608	306.83	3.50	40.12	47.02	397.48
Grand Jury	306,701	0.97	0.01	0.13	0.15	1.26
Health Services	675,907,574	2,135.60	24.37	279.27	327.26	2,766.51
Human Relations Commission (2)	358,317	1.13	0.01	0.15	0.17	1.47
Human Resources	1,523,782	4.81	0.05	0.63	0.74	6.24
Internal Services	26,080,083	82.40	0.94	10.78	12.63	106.75
Mental Health	20,732,260	65.51	0.75	8.57	10.04	84.86
Military & Veteran Affairs	546,078	1.73	0.02	0.23	0.26	2.24
Museum of Art	13,454,462	42.51	0.49	5.56	6.51	55.07
Museum of Natural History	19,533,881	61.72	0.70	8.07	9.46	79.95
Music Center	31,608,935	99.87	1.14	13.06	15.30	129.38
Office of Public Safety	2,078,088	6.57	0.07	0.86	1.01	8.51
Parks & Recreation	1,146,188,384	3,621.50	41.33	473.58	554.96	4,691.38
Probation	140,287,418	443.25	5.06	57.96	67.92	574.20
Public Defender	20,751,709	65.57	0.75	8.57	10.05	84.94
Public Health	23,904,000	75.53	0.86	9.88	11.57	97.84
Public Library	48,484,987	153.19	1.75	20.03	23.48	198.45
Public Social Services	35,560,894	112.36	1.28	14.69	17.22	145.55
Public Works	197,832,062	625.07	7.13	81.74	95.79	809.73
Regional Planning Commission	3,523,325	11.13	0.13	1.46	1.71	14.42

Department	Water Consumption (gallons)	GHG Emissions ($MTCO_2e$)				
		Water Supply and Conveyance	Water Treatment	Water Distribution	Wastewater Treatment	Total
Registrar Recorder	16,698,764	52.76	0.60	6.90	8.09	68.35
Sheriff	425,260,800	1,343.66	15.33	175.71	205.90	1,740.60
Superior Court	301,358,712	952.17	10.87	124.52	145.91	1,233.47
Treasurer & Tax Collector	11,690,556	36.94	0.42	4.83	5.66	47.85
Total	3,449,607,896	10,899.40	124.38	1,425.31	1,670.24	14,119.33

4.11 Scope 3 Emissions

As stated above, Scope 3 emissions include indirect emissions that are not considered to be Scope 2 emissions and are not under the control or influence of the local government. The County determined that specific Scope 3 emissions should be included in this inventory, as these emissions may be reduced by future actions undertaken by the County. The Scope 3 emissions included in this report are: waste generation and employee commute.

4.11.1 Waste Generation

This inventory includes direct landfill emissions of methane from County-owned landfills as Scope 1 emissions. However, emissions also result from the decomposition of waste that is generated by the County's employees and daily operations. These "waste generation" emissions are considered from a lifecycle perspective, including: upstream emissions (i.e., emissions produced as a result of raw material manufacture) and downstream emissions, including emissions offset through the recycling process, as well as the methane that will be emitted from landfills in future years due to the decomposition of waste that is generated in the current year. The methane that will be emitted from landfills in future years due to the decomposition of waste that is generated in the current year is included as Scope 3 emissions in the inventory because reporting these emissions is considered to be optional (CARB et al. 2010). However, per the LGOP, the upstream emissions and the other downstream emissions are not included in the inventory as Scope 3 emissions, but are listed below for informational purposes. Estimates of waste generated by County departments and the associated GHG emissions are listed in Table 15, for the waste generation data that was available.

4.11.1.1 Data Acquisition and Sources

Waste generation data was obtained from information contained in contractual agreements between the County and the various waste hauling entities. Copies of these contracts were provided by the Internal Services Department (pers. Comm.Sehgal, Ritu, 2010). The waste hauler contracts indicate the volume and number of waste containers

collected at each facility and the frequency of collection. Waste composition information was taken from from the CalRecycle waste profile website (CalRecyle, 2010b).

4.11.1.2 Emissions Calculations / Methodologies

GHG emissions due to waste generation include two distinct components: 1) future methane emissions that result when this waste is landfilled and 2) upstream and downstream lifecycle emissions that result from the energy used to produce and transport the materials. This analysis accounts for both components, both of which are "lifecycle" emissions. A "lifecycle" accounting of solid waste emissions provides a more complete understanding of the County's GHG emissions "footprint" for this sector. The methodologies used to calculate future waste emissions from the landfill and other lifecycle emissions are described below.

4.11.1.2.1 Future Waste Emissions (Landfill) – Included as Scope 3

The materials disposed of by the County's employees are recycled, composted, or placed in a landfill. Landfill-related emissions from waste are primarily methane, which is released over time when waste decomposes in a landfill. Current-year emissions from landfills owned and operated by the County are reported separately above. These emissions result from the deposition in landfills of waste that has been generated in the past. Future waste emissions represent the methane emissions that will result in the future from County municipal waste that is generated in the current year; as such, these emissions are not a duplication of the emissions associated with the Landfill sector above even though they may occur at County-owned landfills. Further, although the physical GHG emissions that result from the decomposition of the County's waste may occur at a landfill outside of the County's jurisdictional boundaries but is a result of activity that is under the County's jurisdictional control. It is likely that most County-generated waste is landfilled at County-owned landfills.

It was assumed that the waste profile of County-generated waste is the same as average business waste generated by the County as a whole. This was profile information was obtained from the CalRecycle waste profile website (CalRecyle, 2010b).

Future methane emissions from waste generated by County operations and facilities were estimated using emission factor components (e.g. paper, cardboard, grass, kitchen waste, plastics, aluminum etc.) derived from the USEPA report *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (USEPA 2006). The waste containers for each facility, as listed in the waste hauler contracts, were assumed to be 100% full at each pick-up and 100% of this material was assumed to be land-filled. This is likely a conservative estimate because not all bins will be completely full at each pick-up. However, some pick-ups may include waste beyond that indicated by the rubbish bin size on the contract. It is assumed that recycling and compost pick-up are conducted under separate contracts and that the waste hauler agreements only reflect waste that is ultimately buried. It was also assumed that each cubic yard of waste picked up weights 430 pounds (USEPA 1997).

4.11.1.2.2 Other Lifecycle Emissions (Upstream and Downstream) – Informational Item

Waste disposal activities result in more sources of emissions than the methane emissions produced as solid waste decomposes in a landfill. For example, the materials disposed of by the County required energy to manufacture and transport to the County: these emissions are called *upstream* emissions. Emissions offset through the recycling process, such as emissions associated with manufacturing materials without recycled components, are called *downstream* emissions.

Data used for this analysis include waste hauler contracts and waste stream profile information from CalRecyle as described above. Both upstream and downstream emissions were calculated using emission factor components for recycling and landfilling from the USEPA (2006).

From a lifecycle perspective, recycling waste often results in a net emissions sink, because recycling is assumed to displace 100 percent virgin material inputs during the manufacturing process. This sink is a component of the downstream emissions profile of solid waste. Data on recycled waste quantities by waste type was unavailable.

4.11.1.3 Data Gaps

The estimate provided below for total waste generation by County operations and facilities is based on information provided by three waste hauling companies, which are contracted by the County to pick-up waste from a large number of County buildings and facilities. It should be noted that information provided by these three companies does not capture all waste generated by County facilities, as waste pick up for many facilities is contractually bundled with other custodial services provided for a specific location. The amount of waste collected at facilities not covered by the three large contracts is unknown. It is also unknown what percentage of waste generated by the County is collected by these contractors. In addition, data provided by these waste hauling companies was not complete. For example, often only the size of the waste bin at the location was provided, and not tons of waste picked up. Consequently, the estimates of waste generation by department as well as the resulting emissions are rough estimates and should be revised once more accurate and comprehensive data is available. It should be noted that it is un-common for City or County jurisdictions, especially large ones, to track the tons of waste that are produced on-site, at individual facilities. Waste tonnages are typically only measured at the site of disposal. Future efforts to track waste collection and diversion (to recycling or composting) should occur at the department level; this would allow for quantitative GHG emissions estimates and help create effective and targeted waste reduction and recycling programs.

Facilities listed on the three waste hauling contracts do not capture 100% of waste facilities owned and operated by the County. Waste hauling services for many County services is bundled with custodial services for the building or facility and is thus not captured in one of the larger waste hauling contracts (pers. Comm., Carole Lozano, 2010). At

this time, the percentage of waste pick-up that is captured by the waste hauler contracts is unknown. ICF estimates that the waste hauler agreements include over 600 pick-up locations. The waste hauling contracts indicate the maximum amount of waste that the hauler is contracted to pick-up, however it is unknown if all specified bins are full at every pick-up, or if pick-up occurs at the maximum frequency listed in the contract. It is also unknown how much material the County recycles and composts.

According to CalRecycle, municipal operations produce approximately 0.59 tons of solid waste per employee per year (CalRecycle 2010c). Applying this factor to the County's workforce yields about 60,000 tons of waste. The three waste contracts cover the collection of approximately 30,000 tons of waste, indicating that the emissions presented below are likely 50% or less of the actual emissions associated with County waste generation.

In addition, the waste hauling data does not include information regarding the composition of the waste. Because methane emissions from decomposition of solid waste are dependent on the waste type (i.e. paper, food waste, plastic, etc.), specific waste profile information would improve the accounting of waste emissions. Further, the data provided includes *volume* of waste bins, as opposed to *weight*. Consequently, a conversion factor was used to estimate the weight of waste generated by County facilities.

4.11.1.4 Waste Generation Emissions

Table 15 presents waste generated during 2009 by department, future methane emissions from landfills, and upstream and downstream lifecycle emissions from the waste.

Table 15. Waste Generation Emissions by Department

Department	Waste Generation – Landfilling (tons)	Future Waste Emissions (Landfill) ($MTCO_2e$)	Other Lifecycle Emissions ($MTCO_2e$)[1]		
			Upstream	Downstream	Total
Affirmative Action Commission	0	0	0	0	0
Agricultural Comm/Weights & Measures	129	23	127	-1	126
Alternate Public Defender	0	0	0	0	0
Animal Care & Control	105	19	103	-1	103
Arts Commission	0	0	0	0	0
Assessor	0	0	0	0	0
Auditor-Controller	0	0	0	0	0
Beaches & Harbors	2,037	369	2,008	-15	1,992
Board of Supervisors	0	0	0	0	0
Chief Executive Office	0	0	0	0	0

Department	Waste Generation – Landfilling (tons)	Future Waste Emissions (Landfill) ($MTCO_2e$)	Other Lifecycle Emissions ($MTCO_2e$)[1]		
			Upstream	Downstream	Total
Chief Information Office (1)	0	0	0	0	0
Children & Family Services	0	0	0	0	0
Child Support Services	351	64	346	-3	343
Community And Senior Services	0	0	0	0	0
Consumer Affairs	0	0	0	0	0
Coroner	0	0	0	0	0
County Counsel	0	0	0	0	0
District Attorney	0	0	0	0	0
Fire	0	0	0	0	0
Grand Jury	673	122	663	-5	658
Health Services	74	13	73	-1	72
Human Relations Commission	7,656	1,387	7,546	-57	7,489
Human Resources	0	0	0	0	0
Internal Services	1,941	352	1,913	-14	1,898
Mental Health	0	0	0	0	0
Military & Veteran Affairs	0	0	0	0	0
Museum of Art	0	0	0	0	0
Museum of Natural History	661	120	652	-5	647
Music Center	0	0	0	0	0
Office of Public Safety	0	0	0	0	0
Parks & Recreation	2,408	436	2,374	-18	2,356
Probation	831	151	819	-6	813
Public Defender	0	0	0	0	0
Public Health	882	160	870	-7	863
Public Library	1,471	267	1,450	-11	1,439
Public Social Services	0	0	0	0	0
Public Works	5,829	1,056	5,745	-43	5,702
Regional Planning Commission	0	0	0	0	0
Registrar Recorder	0	0	0	0	0
Sheriff	5,856	1,061	5,771	-44	5,728
Superior Court	0	0	0	0	0
Treasurer & Tax Collector	0	0	0	0	0
Total	30,903	5,600	30,457	-231	30,227

Note: As discussed above, waste generation presented above does not capture 100% of waste generated by County activities, and is based on waste hauler contracts from which precise tons of waste generation was difficult to extract.

Department	Waste Generation – Landfilling (tons)	Future Waste Emissions (Landfill) ($MTCO_2e$)	Other Lifecycle Emissions ($MTCO_2e$)[1]		
			Upstream	Downstream	Total

[1] These emissions are not included in the inventory and are provided for informational purposes.

4.11.2 Employee Commute

Employee commute emissions from the County employees account for approximately 17.5 percent of the County's total Municipal emissions in 2009. These emissions are indirect Scope 3 emissions associated with mobile fuel combustion for transporting employees to and from County worksites. There are over 100,000 County employees. According to data provided by the County, the average employee commute distance is approximately 24 miles per one-way trip.

4.11.2.1 Data Acquisition and Sources

The County provided employee commute survey data that was compiled to meet the SCAQMD's employee commute reduction program requirements. This annual commuter report is compiled and submitted to the SCAQMD by the County's Human Resources division. SCAQMD requires that all County-operated facilities with greater than 250 employees implement an employee commute program; this program is then monitored through an annual survey and report. In 2009 the County operated 154 sites with greater than 250 employees. These worksites are called "regulated" sites. Combined, the 154 regulated sites represent 68,000 employees. The 2009 annual survey was used to provide site-specific disaggregated transportation modes and number of trips per week. Modes of travel include drive alone, motorcycle, carpool (2-6 passengers), vanpool (7-15 passengers), bus, rail, walking, bicycle, and electric vehicle. The annual report did not include commute information for employees commuting in the non-peak window, employees working at non-regulated sites, and commute trip distance.

4.11.2.2 Emissions Calculations / Methodologies

The County provided data listing the number of employees within a 5 mile, 10 mile, and 20 mile radius of each regulated worksite. The County did not provide an average commute distance for employees who commute further than 20 miles. It was assumed that employees who commute more than 20 miles travel an average of 40 miles. This assumption may produce a conservative estimate of emissions since the average trip distance for these employees may be less than 40 miles. Employees commuting in the non-peak window and employees working at non-regulated sites were assumed to follow the same commute patterns as regulated employees.

The total number of trips by mode for each department was determined across all modes of transportation based on the employee commute survey for all regulated sites. Trips for regulated sites were used to develop trips for non-regulated County employees and regulated County employees commuting in the non-peak window (i.e. it was assumed that these employees have the same commute patterns as employees captured in the survey). VMT was determined by multiplying the weekly trips for each mode by the average commute distance for each department. Fuel consumption was determined based on average miles per gallon provided by the EMFAC model, assuming an average speed of 30 mph for light and medium-duty vehicles, and 40 mph for heavy-duty vehicles (SCAG 2003).

Fuel consumption was multiplied by the emission factors presented in Table 2 to determine GHG emissions. Emissions for employees commuting by electric-vehicles were estimated using a two-step process. Total electricity consumption was first determined by multiplying the miles traveled by the average amount of electricity required to charge a plug-in car (PHEV) (Electric Power Research Institute 2007). This value was then multiplied by the electricity emission factors presented in Table 2. Emissions for employees commuting by rail were estimated by multiplying the miles traveled by the rail emission factor presented in Table 2. It was assumed that no emissions occur as a result of employees who walk or bike to work.

4.11.2.3 Data Gaps

There are a few data gaps in employee commute. First, the average commute distance for employees commuting more than 20 miles was not available. Second, commute survey data was only available for regulated employees commuting in the peak window. This data was extrapolated to estimate emissions from non-regulated employees and those commuting in the off-peak window, as discussed above. In the future, a comprehensive employee commute survey which captures the commuting patterns of all County employees, regardless of where and when they commute, and includes commute distances, would help provide a more accurate estimate of employee commute emissions and assist the County in identifying effective commute emissions reduction measures.

4.11.2.4 Employee Commute Emissions

Table 16 below shows estimated County one-way employee commute distances by County department, indicating the number of employees commuting at various distance “bins”. The information provided in this table is based on the 2009 employee survey report. As shown, a significant fraction of employees commute more than 20 miles one way. The data in these tables highlight the potential to achieve GHG emission reductions through additional employee commute measures targeted specifically at employees with these large commute distances. Table 17 below shows County commute GHG emissions by department. Table 18 below shows County commute GHG emissions by mode.

Table 16. Estimated Employee Commute Distances by Department for 2009

Fleet Department	One-Way Commute Distance			
	0-5 miles	6-10 miles	11-20 miles	20+ miles
Regulated County Departments	10	16	47	21
Affirmative Action Commission	66	66	64	206
Agricultural Comm/Weights & Measures	45	83	97	67
Alternate Public Defender	242	463	394	390
Assessor	42	160	204	190
Auditor-Controller	41	79	127	84
Board of Supervisors	35	128	151	205
Chief Executive Office	1,443	2,204	2,091	1,651
Child Support Services	521	475	428	374
Children & Family Services	132	82	132	159
Community and Senior Services	11	14	20	9
Consumer Affairs	17	20	32	140
Coroner	57	146	197	152
County Counsel	231	502	691	739
District Attorney	465	625	1,215	2,091
Fire	2,566	4,389	3,269	9,874
Health Services	24	48	67	161
Human Resources	295	436	760	817
Internal Services	503	1,047	1,210	1,251
Mental Health	151	262	548	516
Parks & Recreation	672	1,066	1,006	3,392
Probation	373	277	277	211
Public Defender	289	307	379	172
Public Library	4,129	3,599	2,834	3,304
Public Social Services	851	789	1,091	1,357
Public Works	33	54	52	50
Regional Planning Commission	200	186	423	158
Registrar Recorder	1,307	1,231	1,834	13,976
Sheriff	71	146	151	168
Treasurer & Tax Collector	63	75	72	161
Subtotal	*14,819*	*18,899*	*19,788*	*41,883*
Un-Regulated County Departments				
Animal Care & Control	4	4	4	10
Arts Commission	43	52	50	111
Beaches & Harbors	3	4	4	9
Chief information Office	105	126	121	270
Community Development Commission/Housing Auth	1	1	1	2

Fleet Department	One-Way Commute Distance			
	0-5 miles	6-10 miles	11-20 miles	20+ miles
Grand Jury	4	5	5	10
Military & Veteran Affairs	7	9	8	18
Museum of Art	4	5	5	11
Museum of Natural History	0	0	0	0
Office of Public Safety	113	135	129	289
Public Health	720	863	826	1,849
Subtotal	*1,067*	*1,279*	*1,224*	*2,741*
Total	15,886	20,179	21,013	44,624

Table 17. 2009 Employee Commute GHG Emissions by Department

Fleet Department	GHG Emissions			
	CO_2	CH_4	N_2O	CO_2e
County Departments				
Affirmative Action Commission	247.50	0.06	1.30	249
Agricultural Comm/Weights & Measures	1,914.18	0.60	13.50	1,928
Alternate Public Defender	864.56	0.24	5.45	870
Assessor	4,579.10	1.36	30.23	4,611
Auditor-Controller	1,856.22	0.52	11.46	1,868
Board of Supervisors	1,066.86	0.31	6.96	1,074
Chief Executive Office	1,909.69	0.54	12.08	1,922
Child Support Services	23,780.50	7.31	165.09	23,953
Children & Family Services	18,255.06	5.61	126.63	18,387
Community and Senior Services	1,574.40	0.48	10.74	1,586
Consumer Affairs	122.68	0.03	0.68	123
Coroner	1,205.99	0.37	8.33	1,215
County Counsel	1,731.43	0.48	10.67	1,743
District Attorney	7,228.13	2.06	45.10	7,275
Fire	21,002.92	6.41	145.52	21,155
Health Services	84,054.54	25.57	572.47	84,653
Human Resources	2,702.33	0.76	16.79	2,720
Internal Services	9,308.60	2.85	64.30	9,376
Mental Health	13,731.71	3.86	86.68	13,822
Parks & Recreation	5,589.69	1.63	36.57	5,628
Probation	29,144.56	8.83	199.36	29,353
Public Defender	2,661.78	0.74	16.06	2,679
Public Library	3,356.96	1.04	23.53	3,382
Public Social Services	35,880.75	11.08	249.16	36,141
Public Works	14,817.07	4.58	103.57	14,925
Regional Planning Commission	505.00	0.14	2.93	508
Registrar Recorder	2,734.79	0.84	18.97	2,755
Sheriff	105,601.79	32.14	727.71	106,362
Treasurer & Tax Collector	1,354.84	0.35	7.38	1,363
Animal Care & Control	1,551.00	0.47	10.58	1,562
Arts Commission	91.97	0.03	0.63	93
Beaches & Harbors	1,070.23	0.32	7.30	1,078
Chief information Office	83.61	0.03	0.57	84
Community Development Commission/Housing Auth	2,600.34	0.79	17.73	2,619
Grand Jury	20.90	0.01	0.14	21
Military & Veteran Affairs	100.33	0.03	0.68	101

Fleet Department	GHG Emissions			
	CO_2	CH_4	N_2O	CO_2e
Museum of Art	175.59	0.05	1.20	177
Museum of Natural History	108.70	0.03	0.74	109
Office of Public Safety	2,784.28	0.84	18.99	2,804
Public Health	17,801.01	5.39	121.38	17,928
Total	425,171.60	128.77	2,899.15	428,200

Table 18. 2009 Employee Commute GHG Emissions by Commute Mode

Fleet Department	GHG Emissions			
	CO_2	CH_4	N_2O	CO_2e
Drive Alone	371,407.65	115.483	2,619.74	374,143
Motorcycle	1,368.30	0.425	9.66	1,378
Carpool	26,481.43	8.234	186.79	26,676
3 Carpool	4,157.59	1.293	29.33	4,188
4 Carpool	1,027.60	0.320	7.25	1,035
5 Carpool	197.55	0.061	1.39	199
6 Carpool	58.15	0.018	0.41	59
7 Vanpool	42.15	0.013	0.30	42
8 Vanpool	24.26	0.008	0.17	24
9 Vanpool	11.71	0.004	0.08	12
10 Vanpool	14.53	0.005	0.10	15
11 Vanpool	1.67	0.001	0.01	2
12 Vanpool	19.63	0.006	0.12	20
13 Vanpool	1.44	0.000	0.01	1
14 Vanpool	43.17	0.013	0.20	43
15 Vanpool	35.60	0.011	0.17	36
Bus	9,218.37	2.861	43.37	9,265
Rail	11,044.58	0.000	0.00	11,045
Evehicle	16.19	0.015	0.06	16
Total	425,171.60	128.770	2,899.15	428,200

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